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July 8, 2002

Spectrum Policy Task Force
Federal Communications Commission
C/O Marlene Dortch
445 12th Street, S.W, TW-A235
Washington, D.C. 20554

RE: ET Docket No. 02-135
Interference Protection Policies as Applied to Pulsed Emission Devices

Dear Spectrum Policy Task Force:

At Preco Electronics we research, design and manufacture a line of small, low-powered, short-range, object-detection radar systems compliant with Title 47, Part 15.249 (5725-5875 MHz). These radars are used on a wide variety of commercial vehicles including school buses, mining trucks, forklifts, and highway service vehicles. Their primary utilization is as a safety device to expand the vehicle operator's awareness of objects near the vehicle. Compliance with Part 15 rules has been the single most significantly antagonistic factor hampering our ability to create a cost-effective, performance-effective device. Our ability to bring the devices to market has been delayed for months and months as a result of trying to get through Part 15 Certification.

If this difficulty was due to obvious violation of clearly stated emissions rules documented within Part 15, then the issue would be our own inability to design within the constraints of the stated rules. But this has not been the case. The problem has come from the FCC's own shifting interpretation of the Part 15 rules as applied to pulsed-emission devices. The trend over the last few years has been to increasingly apply ideal, theoretical, pulsed-emission concepts in a broadening conservative approach. Unfortunately, this has lead to a needlessly restrictive stance, and has greatly diminished the effectiveness of this public safety product line. We have had to redesign the product several times to comply with new rule interpretations, and each time the performance of the product suffers.

Furthermore, the recent release of the First Report and Order allowing for some ultra-wideband pulsed devices (ET Docket 98-153) inexplicably amended Subpart 15.215 to add the following paragraph:

> 15.215, paragraph (c) : "Intentional radiators operating under the alternative provisions to the general emission limits contained in Sections 15.217 *et seq.* and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated. …"

The effect of this monumental addition is to exclude all devices that might operate somewhat wideband, but still might otherwise be within the general emission limits of Subsection 15.209 for emissions outside of the special-allowance bands (15.217 *et seq.)*. The FCC is in effect now allowing **only** ultra-wideband devices and narrowband devices; anything in between is now illegal. This will exclude an enormous range of possible products for no apparent reason.

It is quite clear from ET Docket 98-153, First Report and Order, that occupied spectral density is the primary concern of ultra-wideband devices with respect to potential interference. It makes little sense to arbitrarily exclude other devices which might satisfy these same spectral density limits, but do not strictly meet the present definitions in Subpart F for an ultra-wideband device. A wideband pulsed device which still meets the spectral density and EIRP restrictions set forth in Part 15, Subpart F would be equivalent to an ultra-wideband device with respect to potential interfering emissions.

It would make more sense for the FCC to address a wider range of pulsed emission devices, and adopt a set of compliance rules very similar to those now used in Subpart F to maintain equivalent interference protection.

Adopting such a stance makes even more sense when considering the FCC's present position on measuring pulsed-emission device compliance. In addition to the new forced narrowband restrictions set forth in 15.215, paragraph (c), the FCC has also fairly recently adopted the policy of applying the full pulse desensitization factor (PDF) to off-center pulse spectral-line emissions at band edges and harmonics as a means of estimating worst-case peak power levels at those frequencies.

The term PDF is well defined within a document entitled, "Hewlett Packard Application Note 150-2, Spectrum Analysis, Pulsed RF". This classic treatise on the topic is extremely useful, and is an excellent reference to base policy upon for measurement of emissions from pulsed RF carrier devices. The author of HP Application Note 150-2 thoroughly and accurately addresses pulse desensitization, including the correct methods for accurately measuring all parameters of a pulsed emission.

$$PDF = 20 \text{ Log } (PW * PRF) \quad \text{decibels} \qquad (1)$$

Where: PW is the pulsewidth in seconds
PRF is the pulse repetition frequency in Hertz

The terminology, pulse desensitization, is an unfortunate choice of words which has lead to a great deal of confusion. This perhaps accounts for some of the evolving FCC interpretations of Application Note 150-2 over the last few years. The phrase is meant to indicate that a proper understanding of the spectrum analyzer settings is crucial to accurately evaluate measurements on pulsed waveforms, and the application note goes into great detail explaining how to properly set up the spectrum analyzer and how to interpret the results for differing equipment configurations.

The author of the application note recognized that the terminology was misleading, and at the bottom of page 6 of HP Application Note 150-2 is the following text:

> "The expression 'pulse desensitization' is quite misleading since the sensitivity of the spectrum analyzer is not reduced by a pulse modulated signal."

Pulse desensitization is mentioned only once in all of Part 15, within Subsection 35, paragraph (a), for frequency measurements below 1000 MHz:

> 15.35, paragraph (a) : "As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, …"

It is likely that this is mentioned specifically within paragraph (a) addressing measurements below 1000 MHz because at these lower frequencies it takes great care to achieve true line spectrum mode equipment settings. There will likely be a very low pulse repetition frequency, which creates spectral lines very closely spaced and requires very narrow resolution bandwidth settings to resolve. If care is not taken, then a pulse spectrum or partial pulse spectrum is measured and corrections must be applied.

In past testing of pulsed emission devices from several different companies operating above 1000 MHz, the interpretation of the following excerpt from Part 15, subsection 35, was taken quite literally. Note that Subsection 15.35 contains the only direct mentions of pulsed emissions contained within all of Title 47 Part 15 rules, prior to the new report and order adding Subpart F for ultra-wideband devices. (15.231 refers back to 15.35 & Subpart E applicable to National Infrastructure Information Devices has some of its own definitions.)

> 15.35, paragraph (c) : "…, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals …"

Previous device compliance submittals performed emissions measurements with a peak detector and then modified to a calculated average value by subtracting the duty cycle in decibels. Although this method would seem to be the direct implementation of the rules as stated in 15.35(c), it does not adequately address the CW nature of the pulse spectral lines nor do anything to explain how to accurately measure the pulse line spectrum to truly see those lines. Thus the action by the FCC to start applying the concepts of Application Note 150-2 beyond 1000 MHz initially made good sense.

But note that the author of Application Note 150-2 never refers to applying the PDF to any frequency other than the center frequency of the pulse waveform, which is the carrier frequency. Unfortunately, the FCC has recently decided that it is also valid to apply the PDF to other pulse frequency components, particularly at the special-allowance band edges and at the pulse harmonics. This is considered to be justified by the assumption of a possible wideband victim receiver seeing a very large number of the pulse CW spectral components, and these components coherently adding within the receiver to create some peak power represented by adding the PDF to the band-edge value or harmonic center-frequency value.

When a pulse with a low duty cycle is utilized, a very significant PDF results. A numerical example helps demonstrate the implications of utilizing the PDF at the band edges and harmonic emissions. Consider a 10 nanosecond pulse with a 2.5 MHz PRF (one pulse every 400 nanoseconds). From equation (1):

PDF = 20 Log (10x10^-9 * 2.5x10^6)
= 32 dB

And again from Part 15.35:

> 15.35, paragraph (b) : "On any frequency or frequencies above 1000 MHz, the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified …, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated…"

Under the present policy, the PDF must be added to all measured spectral lines to calculate a theoretical peak power which might be experienced in a wideband victim receiver centered at that frequency. In the above example at the band edges and the harmonic frequencies, this equates to operating 12 dB below the general emission limits of Subsection 15.209 in order to comply with 15.35, paragraph (b). Yet the spectral lines themselves are CW; so they are individually measured at the same value using both average and peak detectors. These lines are already at "peak" value, and forcing operation so far below the general 15.209 limits (an additional 12 dB!) to satisfy a very questionable calculation is debilitating to equipment performance and is simply unnecessary.

This policy of adding the theoretical PDF to the measured CW band-edge emissions and harmonic emissions is flawed on at least four levels.

1) The victim receiver bandwidth must be at least 1/pulsewidth to "see" the full PDF effect. In the case of a 10 nanosecond pulse, this would require a 100 MHz bandwidth in the receiver. In the Notice of Proposed Rulemaking for ultra-wideband devices, ET Docket 98-153, a worst-case victim receiver bandwidth of 50 MHz is assumed, and this forms the basis for defining a realistic peak-to-average ratio allowance in the First Report and Order recently released.
2) The wideband victim receiver bandwidth would have to be centered on the band edge in order to experience the full peak power effect. This is impractical since any receiver designed this way would also receive signals from inside of the special-allowance band and would by necessity have to be designed to withstand interfering peak power signals allowed in that

band. Defining a realistic-sized bandwidth victim receiver (i.e., 50 MHz) with its receive band edges at the special-allowance band edges, and not inside of the band, would provide a more realistic threat evaluation.

3) It is unlikely that phase and amplitude coherency of all frequency terms properly exists at frequencies well off-center for full peak power to be experienced in the victim receiver. This is particularly true at harmonic frequencies. Filtering circuitry, amplification circuitry, dispersion, frequency-dependent delay, antenna phasing, etc., all contribute to phase and amplitude errors which will diminish the actual peak amplitude which might be experienced by a very wideband receiver centered at the band-edges and harmonics of the ISM bands (a very unlikely scenario to begin with).

4) The peak power level experienced via coherent addition of multiple pulse spectral lines is a transient. In order for the full PDF value to be valid, this transient could only maximally last for the duration of the pulsewidth. Unless the response time of the victim receiver is on the order of nanoseconds, this transient will be invisible to the receiver electronics.

In conclusion, it is hoped here at Preco Electronics, Inc. that the FCC will **very soon** adopt a more rational, clearly defined policy for pulsed emission devices. This policy should be based upon the primary concern of interference protection via certification that a device complies with rational spectral density and EIRP emission limits, applicable to realistic victim receivers. The new limits set forth with Subpart F are a good example of this kind of a well-planned, well-defined approach.

Thank you very much for this opportunity to comment.

Sincerely,

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